Active Project (2016 - 2016)

Fan Duct Heat Exchanger for Turbine Cooling Air, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The proposal is for the design of a fan duct heat exchanger in order to improve aircraft fuel burn. The fan duct heat exchanger decreases the temperature of the 15% to 20% of compressor discharge air used to cool the High Pressure Turbine(HPT). Reducing the HPT cooling air temperature reduces the amount of cooling air needed for HPT cooling, and reducing vane and rotor blade cooling improves engine Specific Fuel Consumption(SFC). Fuel burn is adversely affected by any added engine weight due to the heat exchanger. Fan duct air is much colder than compressor discharge air, and can be used as a cold sink for cooling the HPT cooling air. Parametric analyses will be done to determine the SFC reduction as a function of cooling air temperature decrease. Pressure losses for both sides of the heat exchanger will be part of the analyses. The fan duct heat exchanger has large pressure differentials between the high pressure compressor discharge air and the relatively low pressure fan duct air. Structural analyses will be done for the heat exchanger to determine heat exchanger weight.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed work advances the NASA Aeronautics program goal of reduced fuel burn by using a fan duct heat exchanger. Reducing fuel burn, and the consequent reduction of CO_2 emissions, is a goal of the Environmentally Responsible Aviation(ERA) component of the NASA Aeronautics program. A fan duct heat exchanger reduces both HPT first stage vane and rotor blade cooling requirements when T40 and T41 are unchanged. Precooling vane coolant air also permits a smaller temperature difference between the combustor outlet temperature, T40, and the rotor inlet temperature, T41. If T40 decreases, NOx production is decreased, since NOx is very sensitive to T40 . If T41 is increased, SFC improves due to a higher rotor inlet temperature.

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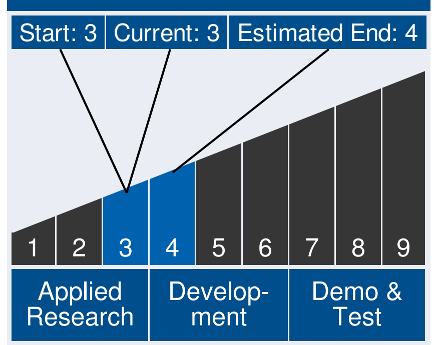
Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

To quantify fuel burn reduction the heat exchanger weight must be known. Applications where the fuel-to-payload fraction is high, or where there is a premium for reduced fuel consumption benefit from a light weight fan duct heat exchanger. The primary benefit of increased turbine inlet temperature is in the reduction of SFC.

To the commercial space industry:

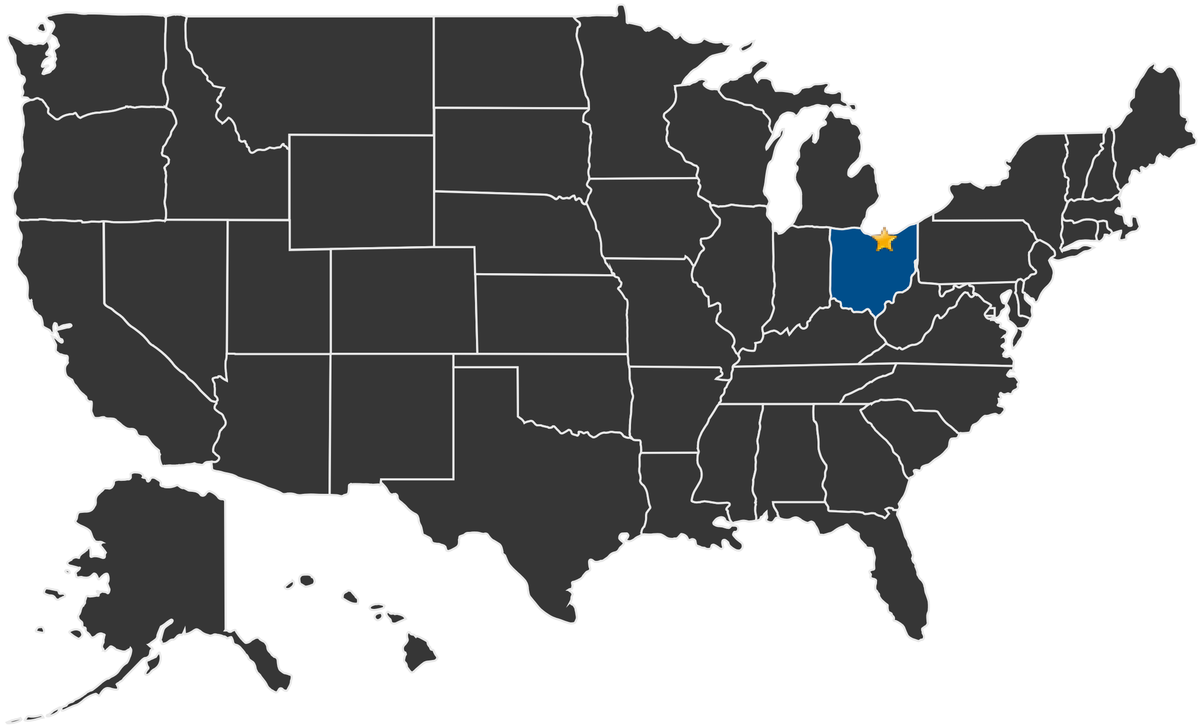
Potential Non-NASA Commercial Applications: The proposed work advances the NASA Aeronautics program goal of reduced fuel burn by using a fan duct heat exchanger. Reducing fuel burn, and the consequent reduction of CO2 emissions, is a goal of the Environmentally Responsible Aviation(ERA) component of the NASA Aeronautics program. A fan duct heat exchanger reduces both HPT first stage vane and rotor blade cooling requirements when T40 and T41 are unchanged. Precooling vane coolant air also permits a smaller temperature difference between the combustor outlet temperature, T40, and the rotor inlet temperature, T41. If T40 decreases, NOx production is decreased, since NOx is very sensitive to T40 . If T41 is increased, SFC improves due to a higher rotor inlet temperature. To quantify fuel burn reduction the heat exchanger weight must be known. Applications where the fuel-to-payload fraction is high, or where there is a premium for reduced fuel consumption benefit from a light weight fan duct heat exchanger. The primary benefit of increased turbine inlet temperature is in the reduction of SFC.

Management Team ***(cont.)***

Principal Investigator:

- Robert Boyle

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

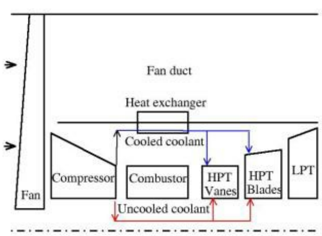
- N&R Engineering (Parma Heights, OH)

PROJECT LIBRARY

<u>Presentations</u>

- Briefing Chart
  - (http://techport.nasa.gov:80/file/23565)

IMAGE GALLERY



Fan Duct Heat Exchanger for Turbine Cooling Air, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

Fan Duct Heat Exchanger for Turbine Cooling Air, Phase I

Potential Applications

The proposed work advances the NASA Aeronautics program goal of reduced fuel burn by using a fan duct heat exchanger. Reducing fuel burn, and the consequent reduction of CO2 emissions, is a goal of the Environmentally Responsible Aviation(ERA) component of the NASA Aeronautics program. A fan duct heat exchanger reduces both HPT first stage vane and rotor blade cooling requirements when T40 and T41 are unchanged. Precooling vane coolant air also permits a smaller temperature difference between the combustor outlet temperature, T40, and the rotor inlet temperature, T41. If T40 decreases, NOx production is decreased, since NOx is very sensitive to T40 . If T41 is increased, SFC improves due to a higher rotor inlet temperature. To quantify fuel burn reduction the heat exchanger weight must be known. Applications where the fuel-to-payload fraction is high, or where there is a premium for reduced fuel consumption benefit from a light weight fan duct heat exchanger. The primary benefit of increased turbine inlet temperature is in the reduction of SFC.